

ELECTROLUMINESCENT DISPLAY DEVICE AND METHOD FOR ITS FABRICATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electroluminescent display device (hereinafter referred to as an "EL display device") and more particularly to a large surface-area EL display device.

2. Description of Related Art

With the recent advent of diversified information processing units, there is an increasing need for flat display elements which consume less electricity and have less weight compared to generally-employed CRTs. An EL element has received notice as one type of such flat display elements. The EL elements are generally classified into two categories depending upon the materials used: inorganic EL elements and organic EL elements.

The inorganic EL elements include a luminescent portion which emits light when its luminous centers are excited by bombardment of electrons accelerated in the intense electric field applied.

On the other hand, the organic EL elements utilize the fluorescent emission of an organic molecule that occurs when it returns to a ground state from an excited state upon recombination of an electron from an electron injecting electrode with a hole from a hole injecting electrode at its luminous center.

If the inorganic EL elements are to be driven, a high voltage in the range of 100–200 V must be applied to produce an intense electric field. In contrast, the organic EL elements can be driven at a lower voltage in the approximate range of 5–20 V. Another advantage is that the suitable selection of luminophors results in different color emissions of the organic EL elements, which makes them suitable for use in multi-color and full-color display devices.

These EL elements have excellent features distinguished from liquid crystal displays, such as spontaneous emissions, independence of view angle and thickness reduction resulting from elimination of a back light, and their applications on large surface-area display devices have been energetically researched and developed.

A variety of modes have been investigated for driving display devices utilizing such EL elements, as similar with the case of liquid crystal displays. A driving mode utilizing a TFT or other switching element positioned in each pixel has gained attention for its higher contrast ratio and middle tone characteristics. In the case of organic EL elements which are current-driven light emitting elements, a current of about 20–30 mA must be supplied to each pixel. It is difficult to realize such a current level with the use of a cell array or driver circuit constructed using amorphous silicon TFT. This necessitates a cell array or driver circuit constructed using polycrystalline silicon TFT. Silicon, when deposited on a glass substrate or the like, must be crystallized at a low temperature. That is, the use of low-temperature polycrystalline silicon TFT as a switching element becomes necessary.

It is however difficult to deposit, in the form of a uniform film, the low-temperature polycrystalline silicon on a large surface-area substrate. This has been one of barriers to area expansion of organic EL display devices.

SUMMARY OF THE INVENTION

A first object of the present invention is to provide an EL display device, such as an organic EL display device, which has a sufficient structural strength and can be fabricated in a large size.

A second object of the present invention is to provide a process for fabrication of an EL display device, which enables size increase of EL display devices if incorporating circuits (e.g., switching circuits) that are unsuited for large surface-area formation.

The EL display device in accordance with a first aspect of the present invention is characterized as being increased in size by securing plural small-size panels, each carrying plural EL elements on its substrate, to a large-size support by an adhesive layer which faces toward those EL elements.

The EL elements are known as having a tendency to deteriorate when exposed to moisture, and thus require a sealing metallic form, called a can, or the like which is attached in such a fashion to seal them from an ambient environment. In the first aspect, plural small-size panels are secured to a large-size support by an adhesive layer which faces toward those EL elements. This measure used to increase sizes of EL display devices serves not only as a sealing means for preventing the aforementioned deterioration but also as a reinforcing means for sustaining the strength of the display devices. Therefore, the first aspect simultaneously achieves sealing of the EL elements, reinforcement and size increase of the display devices.

In the first aspect, a transparent substrate, such as a glass substrate, can be used as a substrate for the small-size panel. In such an instance, the glass substrate may define a light-exiting side of the device, so that a light emitted from the EL element exits the device through the glass substrate. The large-size support facing toward the EL elements is then located opposite to the light-exiting side of the device.

In general, an electrode of the EL element placed on the light exiting side is a transparent electrode such as of ITO. Another electrode such as of a metal film is placed on the opposite side. This metal film electrode is opaque and reflects a light in a manner unique to a metal surface. Accordingly, the region where there is a metal electrode provides a different appearance from the region where there is no metal film electrode. Such an uneven appearance can be improved with the use of a large-size support made of a metal or having a metallic film laminated on its attachment side, whereby a metal surface is provided even in regions where there is no metal film electrode. Particularly, the presence of such a metallic support or metallic film at gaps created between neighboring small-size panels reduces the difference in appearance of the joints between small size panels from the remaining regions.

In the first aspect, the large-size support may be made of transparent material. The use of large-size transparent support permits the involvement of an ultraviolet-curable adhesive layer. That is, an adhesive layer, prior to being cured, may be interposed between the plural small-size panels and the large-size transparent support to join them. The subsequent exposure of the adhesive layer, through the large-size transparent support, to an ultraviolet light source causes it to cure.

In the case where the large-size transparent support is employed, such a large-size transparent support may be located at the side of the device from which a light emitted from the EL element exits. That is, the ITO or other transparent electrode defining an uppermost layer of the EL element may be located to face the large-size transparent support so that a light from the EL element is caused to exit the device through the large-size transparent support.

It is generally preferred that the adhesive layer be provided to overlie an entire area of an attachment surface. However, in the case where the large-size support is located